DOCUMENT RESUME

ED 391 810 TM 024 147

AUTHOR Gonzalez, J. E.
TITLE A First Look at Educational Productivity in Texas.
PUB DATE 27 Jan 95
NOTE 14p.; Paper presented at the Annual Meeting of the Southwest Educational Research Association (Dallas, TX, January 1995).
PUB TYPE Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; *Accountability; Achievement Tests; Databases; *Educational Quality; Elementary Secondary Education; High School Graduates; Models; *Outcomes of Education; *Productivity; Regression (Statistics); Robustness (Statistics); Test Results
IDENTIFIERS Educational Production Function; *Texas

ABSTRACT

This paper explores educational productivity in Texas as it relates to the development of an educational productivity model based on information in the Accountability System of the Texas Education Agency. A number of educational inputs were identified that were found to be related to specific educational outputs. Stepwise regression analysis was used to develop an educational model relating independent variables to dependent variables. Initial results suggested that a richer dataset might be needed to develop a robust model. Data from the Texas Academic Excellence Indicator System (AEIS), which included achievement test scores, were then used to develop revised models. Results of these analyses produced models that were slightly improved over the preliminary models, although it was still difficult to explain much of the variance in student performance outputs from available AEIS educational inputs. In fact, the best educational productivity models that could be derived were those based on graduates and graduates with advanced seals. Appendix 1 contains a bibliography of 20 resources used to prepare this report. Appendix 2 lists the AEIS variables considered. (Contains five tables and nine references.) (SLD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

A First Look at Educational Productivity in Texas

J. E. Gonzalez, Ph.D.

Texas Center for Educational Research
P.O. Box 2947
Austin, TX 78768

Southwest Educational Research Association Conference
Dallas, TX
January 27, 1995

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
J.E. GONZALEZ

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"

ED 391 810

I. Educational Productivity

Introduction:

In the context of economic theory, "productivity" can be maximized with resource allocation decisions, which are based on analysis of inputs and outputs. The mathematical expression for the relationship between inputs and outputs is referred to as a "production function." For over 80 years, researchers have been discussing productivity in the context of educational processes. In general, the body of research that considers the "inputs" of education such as expenditures; as they relate to the "outputs" of education such as student achievement, is referred to as "educational productivity." According to Rossmiller (1979), an educational production function can be represented by an equation that describes the transformation of a set of resource inputs into a desired set of outputs. Rossmiller (1979, p. 6) writes that an educational production function would take the general form:

$$A_{i(t)} = g\,(F_{i(t)}, S_{i(t)}, P_{i(t)}, I_{i(t)}),$$

where:

$A_{i(t)}$	=	Educational outcomes
$F_{i(t)}$	=	Family background characteristics
$S_{i(t)}$	=	School inputs
$P_{i(t)}$	=	Peer or fellow student characteristics
$I_{i(t)}$	=	Initial or innate endowments

The educational outcomes (A) exhibited by a student (i) at a point in time (t), is a function (g) of the student's: family background characteristics (F), school inputs (S), peer or fellow student characteristics (P), and initial or innate endowments (I).

Theoretically, an educational production function should permit the identification of particular combinations of inputs that will maximize the desired output(s) of the educational process. This paper takes a first look at educational productivity in Texas, as it relates to the development of an educational productivity model based on information in TEA's Accountability System.

TEA's Accountability System:

Under statute, the Texas Education Agency (TEA) student accountability system has been designed and implemented to improve student performance (Texas Education Code § 35.063: accreditation standards; and TEC § 35.041: academic excellence indicators). While recognizing diversity among schools and students, the accountability system is intended to identify and publicly recognize high- and low-levels of performance. The mechanism used for reporting accountability information is known as the Academic Excellence Indicator System or AEIS. Since the primary goal of the Accountability System is to improve student performance, perhaps it is prudent to begin to identify AEIS factors that are conceptually related to student performance and that can be empirically tested in an educational productivity model.

TM024147

BEST COPY AVAILABLE

Research Issues:

The Coleman Report (1966) is often cited as the study that first related school district expenditures to student performance. Some twenty years later, Hanushek (1987) is often cited as the researcher that first noted that expenditures were not related to student performance. This important debate continues. For example, Hedges, Laine, and Greenwald (1994), re-analyzed the data that was used by Hanushek and found significantly different results. Can an educational productivity model be developed for Texas? Is the AEIS a meaningful source of information for accountability? This study attempts to develop an educational productivity model, with current district-level information found in TEA's Accountability System.

Educational Productivity in Brief:

Cooper (1993) notes that one of the earliest accounts of educational productivity occurred at a speech presented in 1911, by Houghton Emerson, to the New York Teachers Association. Eighty-three years later, the demand for efficiency and accountability in public education continues. A brief review of the educational productivity literature spanning only fifteen years, includes research that may be grouped into two categories: the philosophical, and the methodological. Philosophical pieces include the work of: Glass, 1979; Smith, 1980; Robinson, 1985; Hanushek, 1987; Ferguson, 1991; Monk, 1992; Franklin, 1993; Genge 1993; Hedges, 1994; Laine, 1994; and Verstagen, 1994. Methodological pieces may be further categorized into studies that utilized "regression" procedures (Aitkin, 1986; Taylor, 1991; Phelps, 1992; and Webster, 19--); or Data Envelopment Analysis (DEA) procedures (Bessent, 1980 & 1984; Arnold, 1993; and Cooper, 1993 & 1994). (Please refer to Appendix 1 for a bibliographic listing of these citations on educational productivity.)

Regardless of design or statistical procedures utilized by the various investigators in these studies, a common "set" of variables emerge from educational productivity research. For example, when analyzed in studies that utilized "regression" procedures, educational inputs such as: teacher literacy, education, and experience; individual ability of students and student socioeconomic status (SES); and school district aspects such as: class size, course offerings, and operating expenditures, were found to be related to educational outputs such as: test scores, and attendance and dropout rates. Table 1 contains a list of variables discussed in this literature.

Table 1
Research Literature: Educational Input and Output Variables Analyzed in "Regression" Procedures

Inputs:	Outputs:
Student:	Student:
% on free lunch	school effectiveness index
% Afro-American	composite of test scores
ethnicity	mean ACT scores
sex	attendance
individual ability	discipline
Teacher:	Teacher:
literacy	teacher attitudes
w/ Ph.D.s	
experience	
District:	District:
demographic data	expenditures
socioeconomic (SES)	class size
class size	pupil/teacher ratio
school report cards	curriculum
operating expenses p-p	
course offerings	

When analyzed in studies that utilized DEA procedures, educational inputs such as: teacher experience and salary; students in special programs, student SES and mobility; and per-pupil expenditures, were found to be related to educational outputs such as: test scores, and attendance and dropout rates. Table 2 contains a list of variables discussed in this literature.

Table 2
Research Literature: Educational Input and Output Variables Analyzed in "DEA" Procedures

Inputs:	Outputs:
Students:	Students:
total students enrolled	attendance
% not low SES	no. not dropouts
% ADA	mean SAT/ACT
mobility	scores in M, R, W
% white	
% minority students	
% non-minority	
no. LEP students	
no. bilingual ed students	
previous year scores on R, M tests	
% continuously enrolled	
% students in attendance	
Teachers:	
mean teacher salary	
mean teacher experience	
no. reg. ed. teachers	
no. spe. ed. teachers	
% faculty in attendance	
District:	
per-pupil expenditures	
pupil/teacher ratio	
minutes per day at math and art	

Methods and Procedures for a Preliminary Model:

In late September 1994, data was obtained in electronic form from the Texas Education Agency in the: Snapshot 92-93 Report. Based on findings in the literature, and available Snapshot data elements, a preliminary empirical model was tested. Educational outputs included: Dropout Rate, Graduation Rate, Graduation with Advanced Seal, Overall TAAS Scores, and SAT and ACT Scores. Educational inputs included: Teacher and Staff FTEs, Teacher/ and Staff/Student Ratios, and school district expenditure information such as: Total Value per-pupil, Total Foundation School Program, Total State Aid, Total Expenditures, and Total Operating Expenditures.

As a preliminary step in the development of an educational productivity model, the statistical procedure, stepwise regression analysis was selected for use in this application. This statistical procedure can be used to identify the independent variables (IVs) that are related to the dependent variables (DVs). The strength or weakness in the relationship between variables is measured by the statistical term R^2. The result of six separate stepwise regression analyses are summarized in Table 3.

Table 3

Results from Stepwise Regression Analyses in the Development of a Preliminary Educational Productivity Model Based on Snapshot 92-93 Data

DVs	Dropout Rate	Graduation Rate	Graduation w/Seal	TAAS	SAT	ACT
R^2	44.603	19.039	18.684	37.619	32.053	44.123
IVs	STFFTE	STFFTE	TCH/STD	STF/STD	STF/STD	STF/STD
	TCHFTE	TCH/STD	TOTVALPP	TCH/STD	TCH/STD	TCH/STD
	STF/STD	TOTVALPP		TOTVALPP	TOTVALPP	TOTVALPP
	TCH/STD			TOTEXP	TOTFSP	STATEAID
	TOTVALPP			TOTOPEXP		
	TOTFSP					

Where:

STFFTE	= Staff FTEs	TOTFSP	= Total Foundation School Program
TCHFTE	= Teacher FTEs	STATEAID	= Total State Aid
STF/STD	= Staff/Student Ratio	TOTEXP	= Total Expenditures
TCH/STD	= Teacher/Student Ratio	TOTOPEXP	= Total Operating Expenditures
TOTVALPP	= Total Value per-pupil		

Discussion of Preliminary Model Results:

In the first model (see Table 3) for example, 45% of the variance in Dropout Rate (educational output) was explained by six educational input variables: Staff FTEs, Teacher FTEs, Staff/Student Ratio, Teacher/Student Ratio, Total Value per-pupil, and Total Foundation School Program. In the sixth model for example, 44% of the variance in ACT (educational output) was explained by four educational input variables: Staff/Student Ratio, Teacher/Student Ratio, Total Value per-pupil, and Total State Aid.

One could argue that none of these six empirical models would be considered particularly robust (an R^2 of 44% explains less than half of the relationship between variables); nor conceptually intuitive (how are staff/student ratios actually related to ACT scores?). As preliminary findings though, the results suggested that perhaps with a richer dataset (i.e., more IVs), an educational productivity model could be developed.

II. The Texas Educational Productivity Model Revisited

The Academic Excellence Indicator System for 1993-94:

AEIS Student Indicators include: TAAS % Passing Scores for Reading, Mathematics, and All Tests Taken for grades: 3-8, and 10; and TAAS % Passing Scores for Writing for grades: 4, 8, and 10. Summarized scores for TAAS include: TAAS % Passing for Reading, Writing, and Mathematics for TAAS 4, 8, and 10; and for TAAS 3-8 and 10. Additional student indicators include: Student Attendance; two Annual Dropout Rate calculations; % Students in Advanced Courses; a TAAS/TASP Equivalence score, and scores for the SAT and ACT.

The AEIS report contains campus- and district-level student performance indicators for eleven groups: state, region, and district totals; and totals for groups by ethnicity, sex, and economically disadvantaged and special education students. Student and staff information as well as school district financial information is reported at the district-and state-level.

AEIS Student Information includes: Total Number of Students, Students by Grade, Students by Ethnicity, and Students identified as Economically Disadvantaged or with Limited English Proficiency. Student retention information includes: Retention by Grade; and information on graduates includes: Overall Graduates, and Graduates with Advanced Seals.

AEIS Staff Information includes: Professional Staff by Category; Number of Educational Aides and Auxiliary staff; Sex and Ethnicity of Teachers; College Degrees and Years of Experience for Teachers; Student/Teacher Ratio; Average Years of Experience for Teachers, and Average Years in the School District for Teachers; Average Salary by Category; Teaching Permits; and Class Size Information.

AEIS District Information includes: Total Tax Rate for 1993; Standardized Tax Rates; Standardized Local Tax Base and Values by Category; Budgeted Revenue information and Budgeted Revenue information by Source; Fund Balance information; Budgeted Expenditure information by Function for Operating and Non-Operating Expenditures; Expenditures by Object; and per-pupil expenditures by Operating and Non-Operating Expenditures. The AEIS also includes Program Information: Student/Teacher Ratio; Student Enrollments by Program; Teachers by Program; and Budgeted Instructional Operating Expenditures by Program.

Methods and Procedures for the Productivity Model:

In late January 1995, data was obtained in electronic form from the Texas Education Agency in the: Academic Excellence Indicator System 1993-94 Report. In ASC-II form, the overall AEIS datasets obtained from TEA included: one campus-level file with 236 variables for each of the 6,343 public schools in the state; and five district-level files with 1,156 variables for each of the 1,046 public school districts in the state. Initially, 278 variables were then subset from these AEIS files (10 Mgs) and prepared for analysis using the "Megafile Management System" of the SYSTAT statistical computer package. SYSTAT and SPSS were then used for data analysis.

Conceptual/Empirical Approach:

The realm of AEIS 93-94 variables that could be considered as components of an educational production function are listed in Appendix 2 (along with descriptive information). Please refer to Table 4 for the result of correlational analysis of student performance indicators measured by TAAS. In light of this analysis, rather than using individual TAAS subtest scores, student performance will be measured by: % Passing TAAS All Tests for 3-8 & 10; and % Passing TAAS All Tests for 4, 8 & 10.

Table 4
Correlation Coefficients for Student Performance Indicators Measured by TAAS.

TAAS:	3-8 & 10 A	3-8 & 10 M	3-8 & 10 R	4, 8 & 10 A	4, 8 & 10 M	4, 8 & 10 R	4, 8 & 10 W
3-8 & 10 All	1.0000	.9821	.8966	.8032	.7649	.6246	.5709
	.	.000	.000	.000	.000	.000	.000
3-8 & 10 Math		1.0000	.8652	.7758	.7702	.6010	.5412
		.	.000	.000	.000	.000	.000
3-8 & 10 Reading			1.0000	.7350	.7122	.7489	.5982
			.	.000	.000	.000	.000
4, 8 & 10 All				1.0000	.9676	.8398	.7868
				.	.000	.000	.000
4, 8 & 10 Math					1.0000	.8411	.7581
					.	.000	.000
4, 8 & 10 Reading						1.0000	.8266
						.	.000
4, 8 & 10 Writing							1.0000
							.

Correlation coefficient: 2-tailed significance test.
" . " indicates that a coefficient was not computed.

Also for purposes of this study, educational outputs will include a measure of TAAS/TASP Equivalence, and SAT and ACT Scores; information about graduates (Total Graduates and Graduates with Advance Seals); and dropouts (Dropout Rate calculated by TEA Method 2). Educational inputs will be measured by student, staff, district, and program variables that conceptually correspond to student performance. Please refer to Figure 1 for a listing of educational inputs/outputs considered in this study.

Figure 1
Listing of AEIS 93-94 Educational Inputs/Outputs

Inputs:

Dropout Rate	Graduates w/ Advanced Seals	TAAS 4, 8 & 10	ACT
TAAS/TASP	Graduates	TAAS 3-8, & 10	SAT

Outputs:

Students:	Variable Name:
Student Attendance Rate	STDATEND
Students in Advance Classes	STDADVCL
Students: All	STDSALL
Students w/ Limited English Proficiency	STDSLEP
Students Economically Disadvantaged	STDSECO
Mobility	MOBILITY
Staff:	
Total Number of Teachers	TOTTCHR
Teachers-No Degree	TCHNOD
Teachers-Bachelors	TCHBA
Teachers-Masters	TCHMA
Teachers-PHDs	TCHPHD
Teachers-Beginning	TCHBEGG
Teachers-1-5 Years	TCH0105
Teachers-6-10 Years	TCH0610
Teachers-11-20 Years	TCH1120
Teachers-20 Years +	TCH20PL
Total Teacher Salary (Base Pay)	TCHRSAL
Total Teacher Years of Experience	TCHREXP
Total Teacher Years at ISD	TCHRISD
Teacher Turnover	TCHRTRN
Teachers-Beginning Salary	TCHBEGGS
Teachers-1-5 Years Salary	TCH0105S
Teachers-6-10 Years Salary	TCH0610S
Teachers-11-20 Years Salary	TCH1120S
Teachers-20 Years + Salary	TCH20PLS
Teachers Temporary permits	TCHTEMP
Teachers Emergency Permits	TCHEMER
Teachers in Regular Ed	TCHREGED
District/Financial:	
Total Tax Rate	TAXRAT
Total Property Value per-pupil	TOTVALPP
Total Revenue per-pupil	TOTREVPP
Total Expenditures per-pupil	TOTEXPPP
Total Operating Expenditures per-pupil	TOTOPRPP
Total Non-Operating per-pupil	TOTNOPPP
Instructional Expenditures per-pupil	INSEXPPP
District/Programmatic:	
Student/Teacher Ratio	TCHKIDR
Class Size Elementary Grades	CSIZEEL
Class Size English	CSIZEENG
Class Size Foreign Language	CSIZEFLA
Class Size Math	CSIZEMAT
Class Size Science	CSIZESCI
Class Size Social Science	SCIZESOC

As in the previous analysis of Snapshot data, a series of stepwise regression analyses were conducted on AEIS data. [The strength or weakness in the relationship between variables being considered in the analysis is measured by the statistical term R^2.] The result of eight separate stepwise regression analyses are summarized in Table 5.

Table 5
Results from Stepwise Regression Analyses in the Development of an Educational Productivity Model Based on AEIS 93-94 Data.

DVs	Dropout Rate	Graduates	Graduates w/Seal	TAAS 3-8,10	TAAS 4,8,10	SAT	ACT	TAAS/ TASP
R^2	24.928	98.465	93.734	31.736	27.230	43.141	43.231	37.847
IVs	- STDATEND	STDADVCL	STDADVCL	STDATEND	STDATEND	TCHRSAL	STDADVCL	STDADVCL
	STDECO	STDSALL	STDSALL	STDADVCL	- STDSECO	TCHBEGGS	TCHREXP	TCHREXP
	- TCHPHD	STDSLEP	STDSLEP	- STDECO	TCH0610	- TOTOPRPP	TCH0105S	- TCHRISD
	- TCH0610	- STDSECO	- STDSECO	- TOTTCHR	TCH20PL	- MOBILITY	- TCH1120S	TCH0105S
	TCHRISD	TCHMA	TCHBA	TCH0610	TCHREXP	TCHKIDR	- TAXRAT	TCHTEMP
	TCHBEGGS	- TCHPHD	- TCHBEGG	TCH20PL	- TCHRISD	CSIZEFLA	- MOBILITY	- TCHEMER
	TAXRAT	TCH0105	- TCH0105	- TCHRISD	- TCHRTRN	CSIZEMAT	- TCHKIDR	- TOTOPRPP
	MOBILITY	TCH0610	- TCHRSAL	- TCHRTRN	TCH1120S		CSIZEEL	- INSEXPPP
	CSIZEFLA	TCH1120	- TCHTEMP	- TAXRAT	- TCH20PLS		CSIZEEFLA	- MOBILITY
	CSIZEMAT	TCH20PL	TCHEMER	- TOTVALPP	- TAXRAT		CSIZEMAT	- TCHKIDR
		- TCHRSAL		- INSEXPPP	- MOBILITY		CSIZESOC	CSIZEENG
		- TCHTEMP		- MOBILITY				CSIZEFLA
		TCHEMER		CSIZEFLA				CSIZESOC
		- TAXRAT						

" - " indicates independent variables are negatively related to the dependent variables.

Results:

Based on AEIS, a much richer dataset than Snapshot; the results of these analyses produced slightly improved models than those found in preliminary models. Still, it is difficult to explain much of the variance in student performance outputs, from available AEIS educational inputs For example, analysis on TAAS 3-8 & 10 resulted in an R^2 of 31.7%; and analysis on TAAS 4, 8 & 10 resulted in an R^2 of 27.2%). However, student variables such as: Student Attendance, Students in Advance Classes, Economically Disadvantaged Students, and Mobility; district variables such as: Tax Rate, Total Values per-pupil, and Instructional Expenditures per-pupil; staff variables such as: Total Teachers, Teacher Experience, and Turnover Rates; and program variables such as: Class Size and Student Teacher ratios, were found to be related to TAAS educational outputs. The same general pattern of student, district, staff, and programmatic inputs held for the educational outputs: TAAS/TASP (R^2 of 37.8%); SAT (R^2 of 43.1%); and ACT (R^2 of 43.2%).

The results of analysis with Dropout Rate as the output variable (R^2 of 24.9%), suggests that the educational inputs that entered into the stepwise regression statistical procedure were only able to explain about one-quarter of the variance in this educational output. From an intuitive perspective, this makes sense: why would these educational inputs be related to educational outputs for students that are no longer participating in the educational process?

There were, however, some interesting results regarding graduates and graduates with advanced seals. Results of these analyses suggest that the best educational productivity models available in AEIS were based on Graduates and Graduates with Advanced Seals as educational outputs. In these models, 98.5% of the variance in Graduates; and 93.7% of the variance in Graduates with Advanced Seals, was explained by student, district, staff, and programmatic input variables.

For the model with Graduates as the output variable, student inputs included: students in advanced classes, total number of students enrolled, number of students identified as LEP, and number of students

that were identified as economically disadvantaged (negatively related); staff inputs included: experience, permits, and salary (negatively related); and the single district input variable in this model was total tax rate which was negatively related. For the model with Graduates with Advanced Seals as the output variable, student inputs also included: students in advanced classes, total number of students enrolled, number of students identified as LEP, and number of students that were identified as economically disadvantaged (negatively related); staff inputs also included: experience, permits, and salary (negatively related). No district input variable loaded into this model.

Discussion:

The primary limitation of this study was that analyses was conducted on district-level data. In the context of the development of an educational productivity model that was intended to describe the inputs and outputs of the educational process, district-level data are far-removed from the daily interaction of teachers and students. A second limitation of this study was that analyses was restricted to multiple regression procedures. DEA procedures were not utilized in this study.

General educational productivity patterns emerged from this data. If one can argue that conceptually, graduation is considered to be a meaningful educational output; then empirically, a set of related inputs were identified from the analyses. Further, based on the educational productivity literature, the educational inputs that resulted from this study were also meaningful: student, teacher, and district variables.

Whereas student performance indicators such as TAAS scores are noteworthy, according to the educational productivity analysis, these variables were not related to educational inputs to the extent that graduation information was. So is AEIS a good accountability system? Since AEIS data was used to conceptually and empirically develop an educational production function, indications are that this information can indeed be used to improve student performance. There are, however, a wealth of variables that still need to be investigated in the AEIS dataset. Perhaps DEA could also be utilized as an analytical procedure.

In regards Rossmiller's educational production function based on family background, school inputs, characteristics of peers, and innate endowments; it seems that district-level information does not sufficiently capture the nuances of the educational process as it relates to individual student-teacher interactions. Perhaps educational processes must be investigated at the campus-level or even at the teacher/classroom-level in order to develop a conceptually and empirically based educational productivity model.

References:

Coleman, J.S.; Campbell, E.Q.; Hobson, C.F.; McPartland, J.; Mood, A.M.; Weifeld, F.D.; & York, R.L. (1966). Equality of Education Opportunity. Washington D.C.: U.S. Department of Health, Education and Welfare, Office of Education, U. S. Government Printing Office.

Cooper, B. S.; Darvas, P.; & Lfano, F. (1994). Administrative and Economic Efficiency in Education: Urg School-Site Ratio Analysis. Paper presented at AERA, New Orleans, LA, April 1994.

Hedges, L. V.; Laine, R. D.; & Greenwald, R. (1994). Does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes. Educational Researcher, 23 (3), 5-14.

Rossmiller, R. A.; Geske, T. G.; Frohreich, L. E.; Doro, M.; & Johnson, H. W. (1979). Resource Utilization and Productivity in IGE Schools. Wisconsin Research and Development Center for Individualized Schooling: University of Wisconsin at Madison.

SPSS. (1993). SPSS for Windows. SPSS, Inc., Chicago, IL.

State of Texas. (1994). AEIS 1993-94. Texas Education Agency.

State of Texas. (1993). Snapshot 1992-93. Texas Education Agency.

Statistica (1994). Statistica for Windows. Statsoft, Inc., Tulsa, OK.

Tabachnick, B. G. & Fidell, L. S. (1989). Using Multivariate Statistics. Harper Collins: New York.

Appendix 1
Bibliographic Listing of Educational Productivity Literature Cited in this Paper

---

Philosophical:

Ferguson, R. F. (1991). Paying for Public Education: New Evidence on How and Why Money Matters. Harvard Journal on Legislation, Vol. 28, No. 2, pp. 466-496.

Franklin, B. J.; Crone, L. J.; Halbrook, A.; & Lang, M. H. (1993). Measures of School Effectiveness: Consistency/Inconsistency When Models are Varied Across Subject Area Tests. Paper presented at AERA: Atlanta, GA, April 1993.

Genge, F. C. (1993). School Curriculum and Technically Efficient Unit School Districts in Illinois: How are they related? Paper presented at the AEFA conference, Albuquerque, NM, March 1993.

Glass, G. V. & Smith, M.L. (1979). Meta-Analysis of Research on Class Size and Achievement. Educational Evaluation and Policy Analysis, Vol.1, No.1, pp. 2-16.

Hanushek, E. A. (1987). Educational Production Functions. Economics of Education: Research and Studies. G. Psacharopoulos (ed.), New York: Pergamon Press.

Hedges, L. V.; Laine, R. D.; & Greenwald, R. (1994). Does Money Matter? A Meta-Analysis of Studies of the Effects of Differential School Inputs on Student Outcomes. Educational Researcher, Vol. 23, No. 3, pp. 5-14.

Laine, R. D.; Greenwald, R.; and Hedges, L. V. (1994). The Use of Global Education Indicators: Lessons Learned From Education Production Functions. Presented at AERA, New Orleans, LA, April 1994.

Monk. D. (1992). Education Productivity Research: An Update and Assessment of Its Role in Education Finance Reform. Educational Evaluation and Policy Analysis, Vol. 14, No. 4, pp. 303-305.

Robinson, G. E. (1985). Effective Schools Research: A Guide to School Improvement. Educational Research Service, Inc., Arlington, VA, February 1985.

Smith, M.L. & Glass, G. V. (1980). Meta-Analysis of Research on Class Size and Its Relationship to Attitudes and Instruction. American Educational Research Journal, Vol.1, No.1, pp. 419-433.

Verstegen, D. A. (1994). Equity is More Efficient: An Analysis of Education Revenue Changes and Student Outcomes. Paper presented at AERA, New Orleans, LA, April 1994.

Methodological--Regression:

Aitkin, M. & Longford, N. (1986). Statistical Modelling Issues in School Effectiveness Studies. Journal of the Royal Statistical Society, Vol. 149, pp. 1-43.

Phelps, J. L. (1992). A Simultaneous Equation Model of Resource Allocation in Education. Lansing, MI: Michigan Department of Education.

Taylor, L. L. & Fox, B. J. (1991). Variations in Texas School Quality. Federal Reserve Bank of Dallas, April 1991.

Webster, W. J.; Mendro, R. L.; & Almaguer, T. O. (19--). Effectiveness Indices: A "Value Added" Approach to Measuring School Effect. Unpublished manuscript, Dallas Independent School District, TX.

Methodological–DEA:

Arnold, V.; Bardhan, I.; Cooper, W. W.; & Kumbhakar, S. C. (1993). DEA Extensions to Statistical Regressions for Efficiency Evaluations – With Illustrative Applications to Secondary Schools in Texas. Paper presented at the 1993 ORSA-TIMS meetings, Phoenix, AZ, December 1993.

Bessent, A. M. & Bessent, E. W. (1980). Determining the Comparative Efficiency of Schools through Data Envelopment Analysis. Educational Administration Quarterly, Vol. 16, No. 2, pp. 57-75.

Bessent, A.; Bessent, W.; Elam, J.; & Long, D. (1984). Educational Productivity Council Employs Management Science Methods to Improve Educational Quality. Interfaces, Vol. 14, No. 6, pp. 1-8.

Cooper, B. S. (1993). Making Money Matter in Education: A Micro-Financial Model for Determining School Efficiency and Productivity. Paper presented at the AEFA conference, Albuquerque, NM, March 1993.

Cooper, B. S.; Darvas, P.; & Lfano, F. (1994). Administrative and Economic Efficiency in Education: Using School-Site Ratio Analysis. Paper presented at AERA, New Orleans, LA, April 1994.

Appendix 2
AEIS Variables in the Realm of Educational Productivity

Variable	Mean	Std Dev	Min.	Max.	Sum	Label
I. Dependent Variables--Educational Outputs:						
TAAS38XA	57.93	12.63	.000	93.200	.	TAAS3-8,10 All Tests
TAAS38XM	62.94	12.35	.000	94.100	.	TAAS%Pass3-8,10 Math
TAAS38XR	78.62	10.33	.000	100.000	.	TAAS%Pass3-8,10 Read
TAAS48XA	54.81	14.53	.000	100.000	.	TAAS4,8&10 All Tests
TAAS48XM	61.05	14.49	.000	100.000	.	TAAS%Pass4,8&10 Math
TAAS48XR	78.44	13.05	.000	100.000	.	TAAS%Pass4,8&10 Read
TAAS48XW	80.47	13.09	.000	100.000	.	TAAS%Pass4,8&10 Write
TAASTASP	2.43	19.61	.000	100.000	.	TAAS/TASP Equivalent
STDSAT	567.05	416.85	.000	1131.000	.	SAT Scores
STDACT	15.82	8.10	.000	25.200	.	ACT Scores
STDGRATE	141.74	388.81	-3.000	6343.000	148256.00	Graduates-Total
STDGRBLK	16.17	108.45	-3.000	2322.000	16919.00	Grads-Afri.American
STDGRHIS	39.90	165.69	-3.000	2326.000	41737.00	Grads-Hispanic
STDGROTR	4.39	23.65	-3.000	367.000	4596.00	Grads-Other
STDGRWHI	81.25	187.73	-3.000	1679.000	84991.00	Grads-White
STDGRADV	55.73	165.53	-3.000	2720.000	58289.00	Grads w/ Advan.Seal
STDDROP1	1.49	1.40	.000	10.000	.	Dropout Rate Method 1
STDDROP2	1.90	1.74	.000	10.500	.	Dropout Rate Method 2
II. Independent Variables--Educational Inputs:						
Students:						
STDATEND	95.60	3.10	.000	99.700	.	Attendand Rate
STDADVCL	10.93	7.75	.000	50.000	.	Advanced Class
STDSALL	3443.44	10569.09	3.000	200445.0	3601839.00	Students All
STDSBLAK	492.07	3264.62	.000	71487.00	514709.00	African American
STDSHISP	1224.13	5195.54	.000	98457.00	1280444.00	Hispanic
STDSWHIT	1642.67	3728.43	.000	33842.00	1718229.00	White
STDSOTHR	84.57	440.65	.000	6882.000	88457.00	Other
STDSECO	1551.73	6077.72	.000	115718.0	1623108.00	Econ.Disadvantaged
STDSLEP	407.21	2300.76	.000	50838.00	425940.00	w/ Lim.Eng.Proficiency
STDSBIED	354.78	2023.73	.000	43453.00	371102.00	in Bilingual Ed
STDSGIED	240.26	827.46	.000	16101.00	251313.00	in Gifted/Talented Ed
STDSSPED	368.19	1027.93	.000	19433.00	385126.00	in Special Ed
STDSVOED	466.25	1286.05	.000	25811.00	487695.00	in Voc.Ed
MOBILITY	17.71	5.67	.000	49.700	.	Student Mobility
Staff:						
TOTTCHR	216.60	625.34	.900	11421.60	226559.60	Total No.of Teachers
TCHBLAK	17.83	183.40	.000	4719.000	18653.60	African American
TCHHISP	31.07	146.55	.000	1782.300	32500.30	Hispanic
TCHWHIT	166.63	399.02	.900	5061.600	174292.40	White
TCHOTHR	1.06	5.83	.000	142.600	1111.70	Other
TCHMALE	46.95	137.08	.000	2659.500	49105.90	Teachers-Male
TCHFEMAL	169.65	491.84	.700	8762.100	177453.00	Teachers-Females
TCHNOD	1.54	5.80	.000	82.000	1612.10	Teachers-No Degree
TCHBA	152.60	412.49	.000	7368.800	159619.30	Teachers-Bachelors

Staff (Continued):						
TCHMA	61.62	212.66	.000	3879.300	64454.60	Teachers-Masters
TCHPHD	.83	6.36	.000	147.600	873.00	Teachers-PHDs
TCHBEGG	13.93	45.70	.000	911.200	1457	5.10Teachers-Beginning
TCH0105	55.50	156.83	.000	2957.700	58056.00	1-5 Years
TCH0610	41.61	113.99	.000	2005.300	43528.20	6-10 Years
TCH1120	68.77	194.75	.000	3255.600	71933.50	11-20 Years
TCH20PL	36.78	124.09	.000	2291.900	38466.70	20 Years +
TCHRSAL	26825.59	2443.47	.000	40000.00	28059568.00	Tchr.Salary:Base Pay
TCHREXP	11.17	2.22	2.400	17.600	.	Tchr Years of Exper
TCHRISD	6.81	2.08	.000	16.200	.	Tchr Years at ISD
TCHRTRN	14.58	8.72	.000	100.000	.	Tchr Turnover
TCHBEGS	16454.46	7399.29	.000	37772.00	17211367.00	Tchr Begin Salary
TCH0105S	21916.71	2995.10	.000	28529.00	22924878.00	1-5 Years Salary
TCH0610S	26408.01	3699.56	.000	33779.00	27622780.00	6-10 Years Salary
TCH1120S	29336.61	3597.72	.000	40000.00	30686089.00	11-20 YearsSalary
TCH20PLS	31322.67	6832.19	.000	48640.00	32763518.00	20 Years + Salary
TCHTEMP	.98	2.27	.000	23.000	.	Temporary Permits
TCHEMER	3.17	10.24	.000	144.000	.	Emergency Permits
TCHSPEC	1.41	9.77	.000	205.000	.	Teachers Special Ed
TCHVOC	.39	1.26	.000	16.000	.	Teachers Voc.Ed
TCHNONR	1.29	5.04	.000	62.000	.	Teachers Non-Renewal
TCHREGED	152.73	393.27	.900	6314.800	159760.70	Teachers in Reg.Ed
TCHSPEED	20.10	64.83	.000	1284.100	21029.20	Teachers in Spec.Ed
TCHCOMED	13.18	97.02	.000	2980.800	13788.80	Teachers in Comp. Ed
TCHVOCED	8.27	21.28	.000	391.500	8649.80	Teachers in Voc. Ed
TCHBILED	13.58	71.94	.000	1091.100	14205.30	Teachers in Bil. Ed
TCHGIFED	4.50	19.74	.000	405.000	4710.30	Tchrs. in Gift/Talent
TCHOTRED	4.22	14.87	.000	244.200	4418.60	Tchrs. in Other Ed
District/Financial:						
TAXRAT	1.32	.20	.000	1.915	.	Total Tax Rate
TOTVAL	600096296	2310641630	.000	4.84E+10	6.2770E+11	Total Property Value
TOTVALP	233358.83	399290.56	.000	5948526	.	Tot.Prop.Val.p-p
TOTREV	16546605	50085536.9	-1.8E+07	9.35E+08	17307748801	Total Revenue
TOTREVPP	5698.97	2937.32	-1647.00	51462.00	.	Tot.Rev.p-p
TOTEXP	16864832	51574117.0	82710.00	9.92E+08	17640613884	Total Expenditures
TOTEXPPP	5708.48	2348.65621	.000	46137.00	.	Tot.Expend.p-p
TOTNOP	1850994.6	5215363.13	.000	87112861	1936140394	Total Non-Operating
TOTNOPPP	611.87	486.89	.000	6618.182	.	Tot.Non-Oper.p-p
TOTOPER	15013837	46600057.9	81260.00	9.05E+08	15704473490	Tot.Operating Expend.
TOTOPRPP	5096.62	2176.48	589.532	44245.51	.	Tot.Oper.p-p
INSEXP	8791258.4	27493231.2	36020.00	5.22E+08	9195656269	Instructional Expend
INSEXPPP	2958.44	968.22	387.698	14800.91	.	Instruct.Exp.p-p
District/Program:						
TCHKIDR	13.51	2.85	3.500	44.900	.	Student/Teacher Ratio
CSIZEEL	17.99	3.89	.000	30.100	.	Class Size Elem.Grade
CSIZEENG	17.11	5.32	.000	31.100	.	Class Size English
CSIZEFLA	14.91	7.75	.000	35.500	.	Class Size For. Lang.
CSIZEMAT	16.77	5.58	.000	28.400	.	Class Size Math
CSIZESCI	17.97	5.36	.000	34.000	.	Class Size Science
CSIZESOC	18.62	5.58	.000	32.000	.	Class Size Soc. Sci.